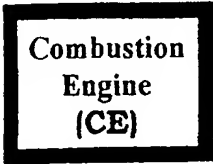



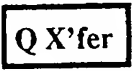










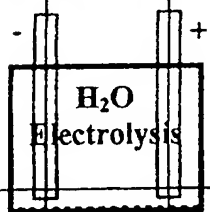

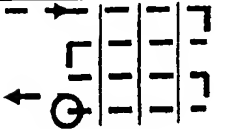
## Replacement Sheet

**Figure 1**  
**WCT Symbols in Flow Diagrams and in Figures 1 through 23A**

Symbol	Description	Notes
	Combustion Engine	CE can be any combustion design as is known in the art, i.e. internal combustion engine, turbine, furnace, etc. CE combines fuel and ignites fuel with a spark generation device. Fuel is most preferably O <sub>2</sub> , H <sub>2</sub> and H <sub>2</sub> O. Fuel is preferably O <sub>2</sub> and H <sub>2</sub> . Fuel can be used in combination with air.
	Gas Compressor	Used in Cryogenic Refrigeration. Designs are plentiful in the art. Compressor symbols: A = Air, D1 = First Distillation, D2 = Second Distillation, O1 = O <sub>2</sub> , H1 = H <sub>2</sub> , O = O <sub>2</sub> Storage and H = H <sub>2</sub> Storage.
	Joule-Thompson Expansion Valve	Two types are normally used in the art – 1. An expansion valve, 2. A cylinder.
	Separation (Distillation Column)	Diameter and Height dependent upon separation efficiency and loading. Separation efficiency dependent upon compounds separated and column packing. Distillation Temperatures are relative to Separation Operating Pressure. Depending on the desired O <sub>2</sub> purity, the second O <sub>2</sub> /N <sub>2</sub> separation column is optional.
	Heat Exchanger to cool compressed gases	During normal operation, it is preferred that the waste N <sub>2</sub> is coolant. Depending upon design, upon start-up water may be necessary for an efficient start-up.
	Cryogenic Storage Tank	Tank is to be made of materials known in the art to withstand liquid cryogenic temperatures/pressure of O <sub>2</sub> and/or H <sub>2</sub> . Tank may have refrigeration loop per Figure 13, which operates off at least one of: the combustion engine, a battery and a fuel cell.
	Turbine	Depending upon application, turbine is to be turned by steam, air or water movement. Turbine is preferred to generate electricity, preferably driving a generator and/or alternator. It is most preferred that the electricity performs electrolysis.
	Pressure Controller	Pressure controller can be of any design as is known in the art. PC protects downstream equipment from pressure surges. In high pressure surge situations, PC vents to the atmosphere.
	Energy in the form of heat	Energy is transferred (managed) during many methods, processes and systems of this invention.
	Fuel Mixture Controller	H <sub>2</sub> , O <sub>2</sub> , H <sub>2</sub> O, air bypass and engine coolant. Controller manages fuel mixture ratios. H <sub>2</sub> O ratio in combustion is managed depending upon combustion temperature and/or engine temperature. Air bypass is to be managed depending upon O <sub>2</sub> tank level. Engine coolant loop dependant on high engine temperature.

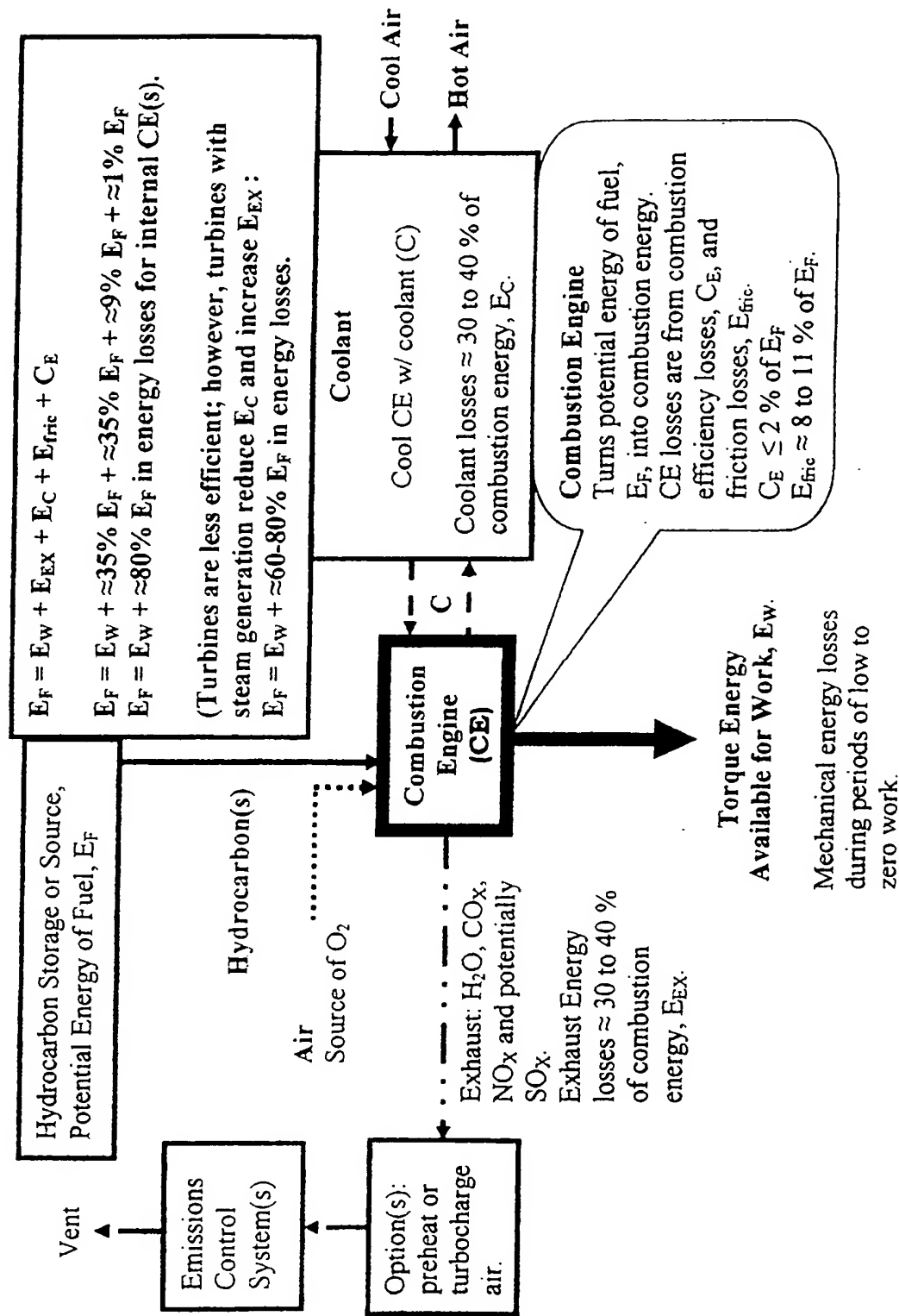
## Replacement Sheet

**Figure 1A**  
**WCT Symbols in Flow Diagrams and in Figures 1 through 23A**

Symbol	Description	Notes
	Clutch	Used to transfer $E_w$ to at least one of a flywheel and a generator. Clutch preferably engages during periods of little to no work and disengaged during periods of work. Design and assembly to be as known in the art.
	Flywheel	Used to store rotational kinetic energy during periods of little to no work; rotational energy to be utilized during periods of work.
	Generator	Used to generate electrical energy. Generator can be of the type to generate an alternating current (A/C), such as in power generation applications or a Dynamo to generate a direct current (D/C) to power electrolysis. A/C current can be turned into D/C with an A/C to D/C converter and D/C can be turned into A/C with a D/C to A/C converter.
	Electrolysis	Electrolysis of $H_2O$ to $O_2$ and $H_2$ is to be performed. Electrolysis is to be performed by methods and systems known in the art of electrolysis. It is most preferred that an electrolyte be present in the $H_2O$ to further electrolysis and the efficiency of electrolysis. It is preferred that the electrolysis unit be cooled.
.....	Air Line	Line primarily contains air.
-----	$O_2$ Line	Line primarily contains $O_2$ .
-----	$N_2$ Line	Line primarily contains $N_2$ .
-----	$H_2$ Line	Line primarily contains $H_2$ .
-----	$H_2O$ Line	Line primarily contains $H_2O$ .
--- . --- .	Products Line	Line primarily contains combustion products, preferably $H_2O$ , yet can be $H_2O$ and X, wherein X is $N_2$ , $CO_x$ and $NO_x$ and can contain $SO_x$ .
-----	Coolant (C) Line	Line symbol indicates flow of coolant, which is preferably used with electrolysis. C can be used with CE; however this is not preferred. C can be any type as is known in the art; coolant is preferred a mixture of water, glycol, corrosion inhibitor and dispersant.
-----	Control Line	Electrical or pneumatic line. Electrical wire carrying a small current, preferably 4 to 20 mA. Pneumatic line may carry a gas and/or a liquid under pressure.
	Flow Transmitter & Control Valve	Used in combination with control line and controller (CONT.) to control flow of fuel and/or coolant (C)
	Coolant Radiator	Used to release heat from coolant and pump back to heat source. Preferably used for electrolysis. Preferably used to cool oil for CE. It is not preferred to cool CE.

# Replacement Sheet

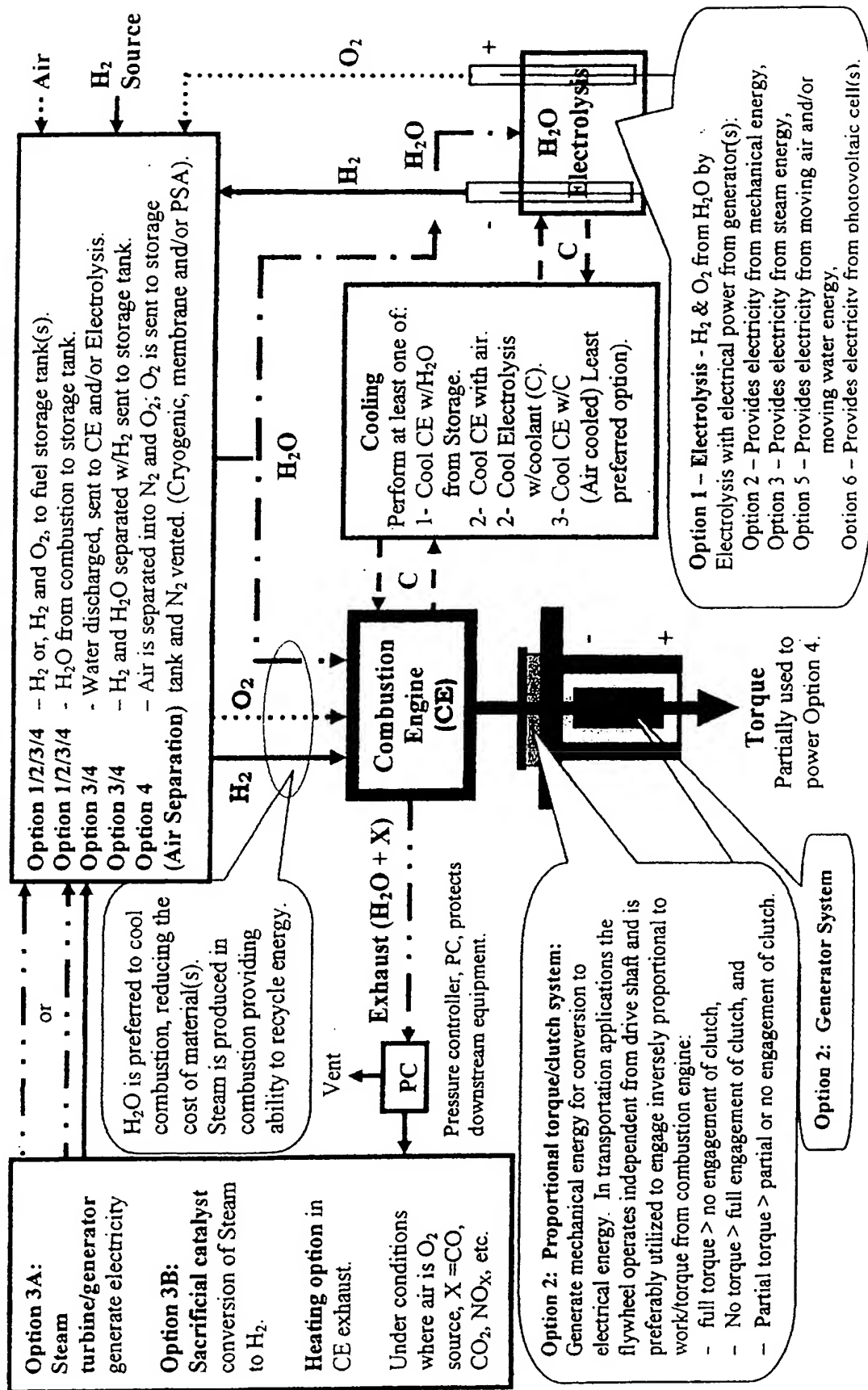
Figure 2  
Traditional Combustion - Combustion Fueled by Hydrocarbon(s) and Air



# Replacement Sheet

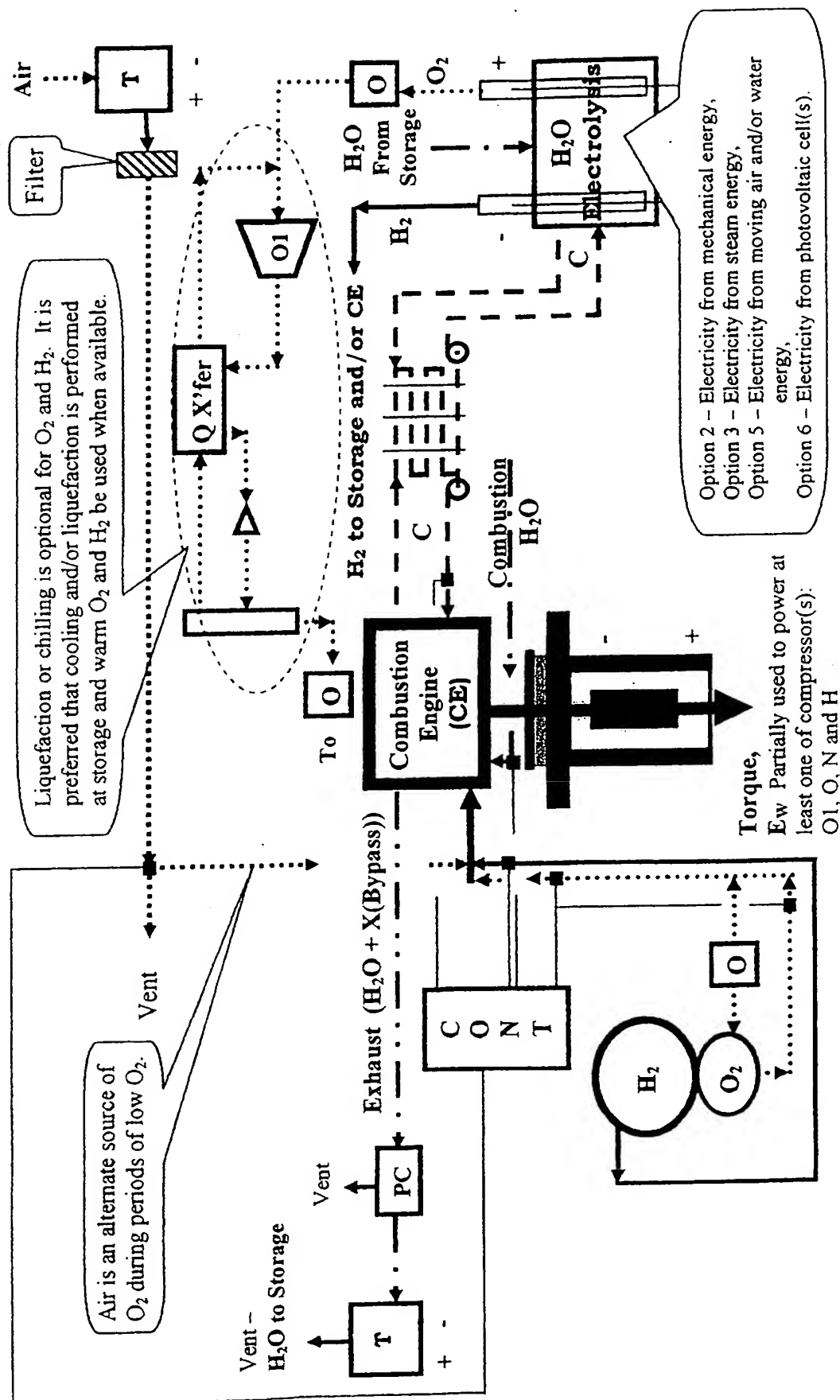
Figure 2A

Combustion Fueled by  $H_2$  and  $O_2$  Having Air as Alternate Source of  $O_2$



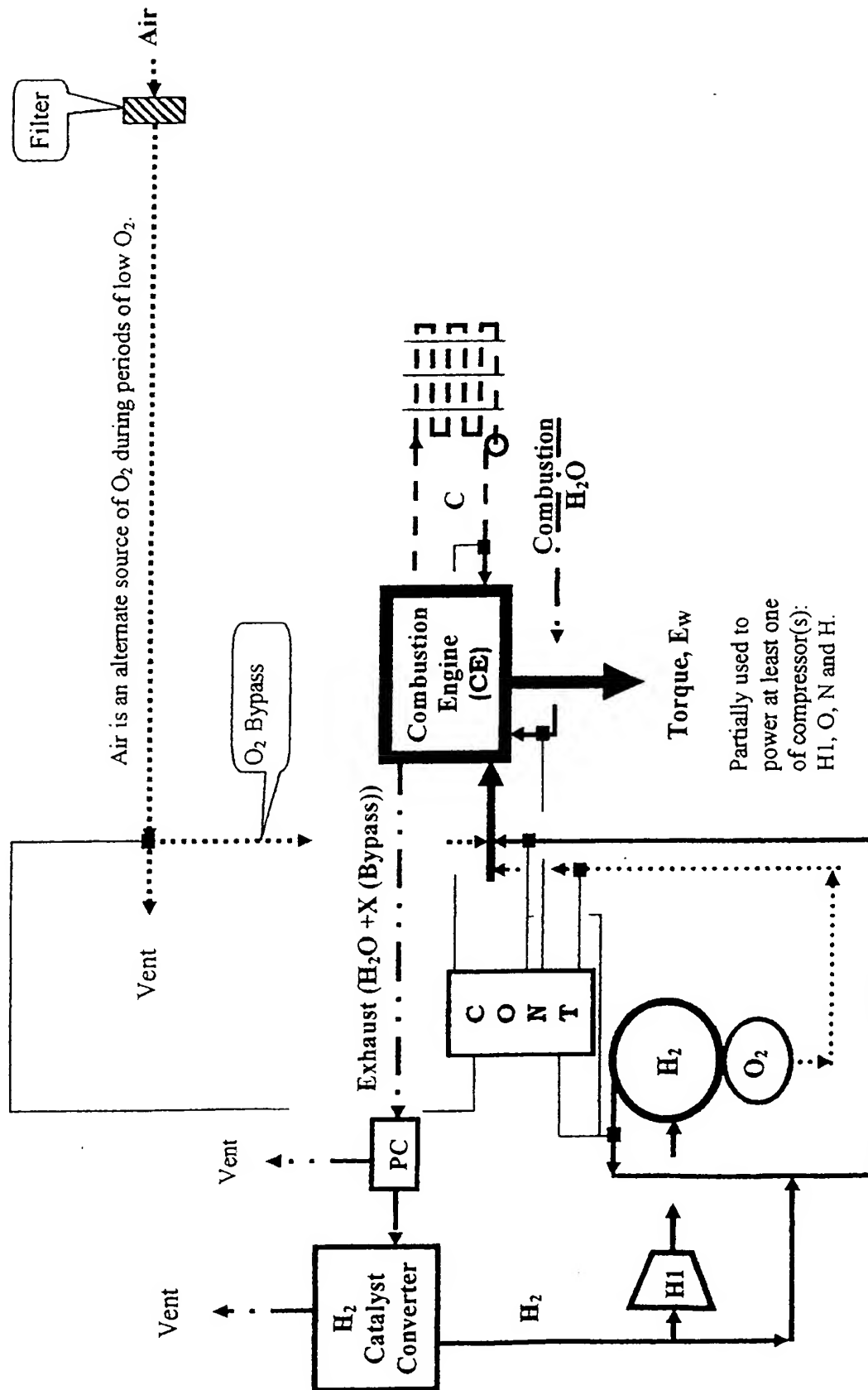
# Replacement Sheet

Figure 3  
Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate- Electrolysis



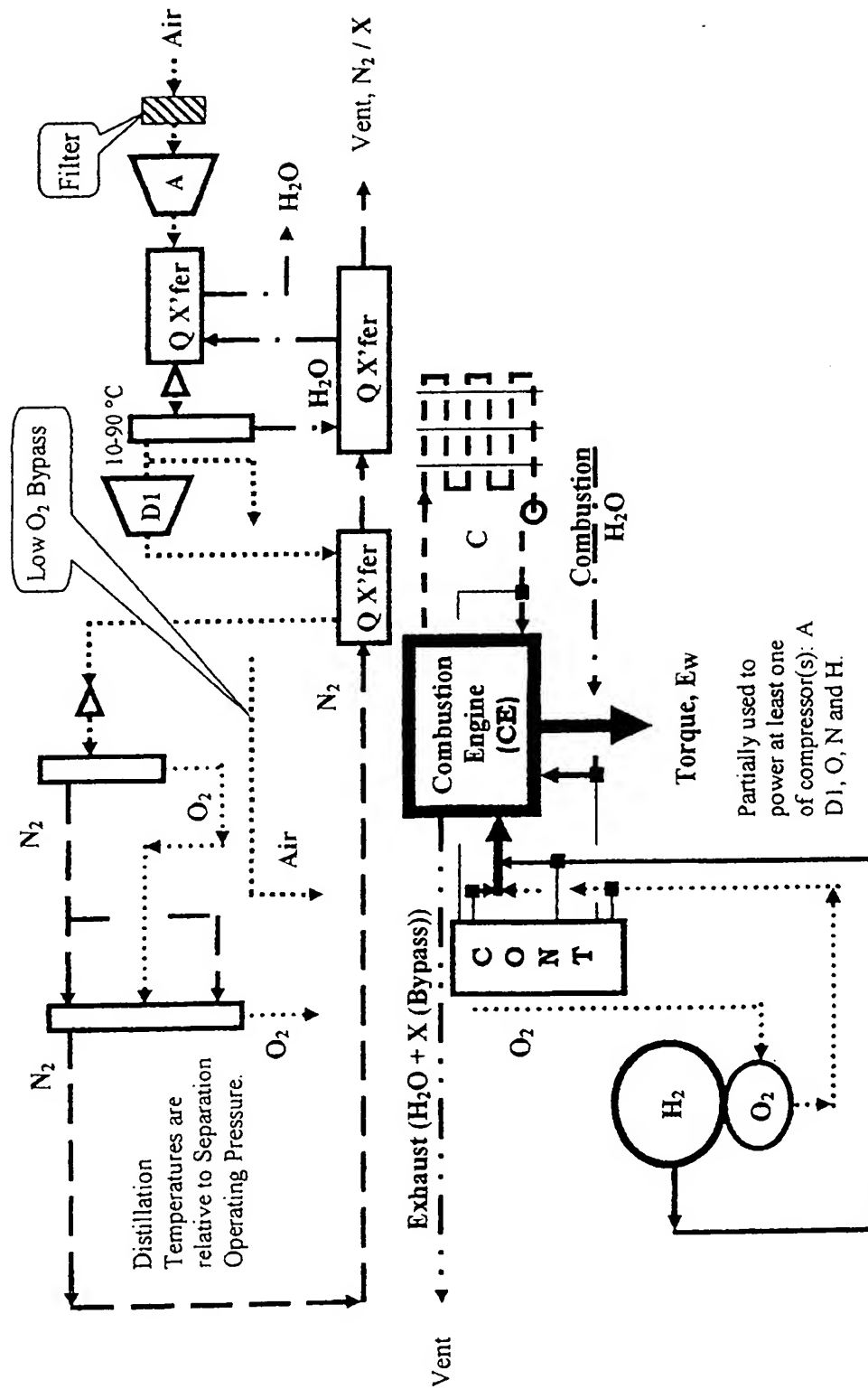
# Replacement Sheet

**Figure 4**  
Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate -  $H_2$  Catalysis



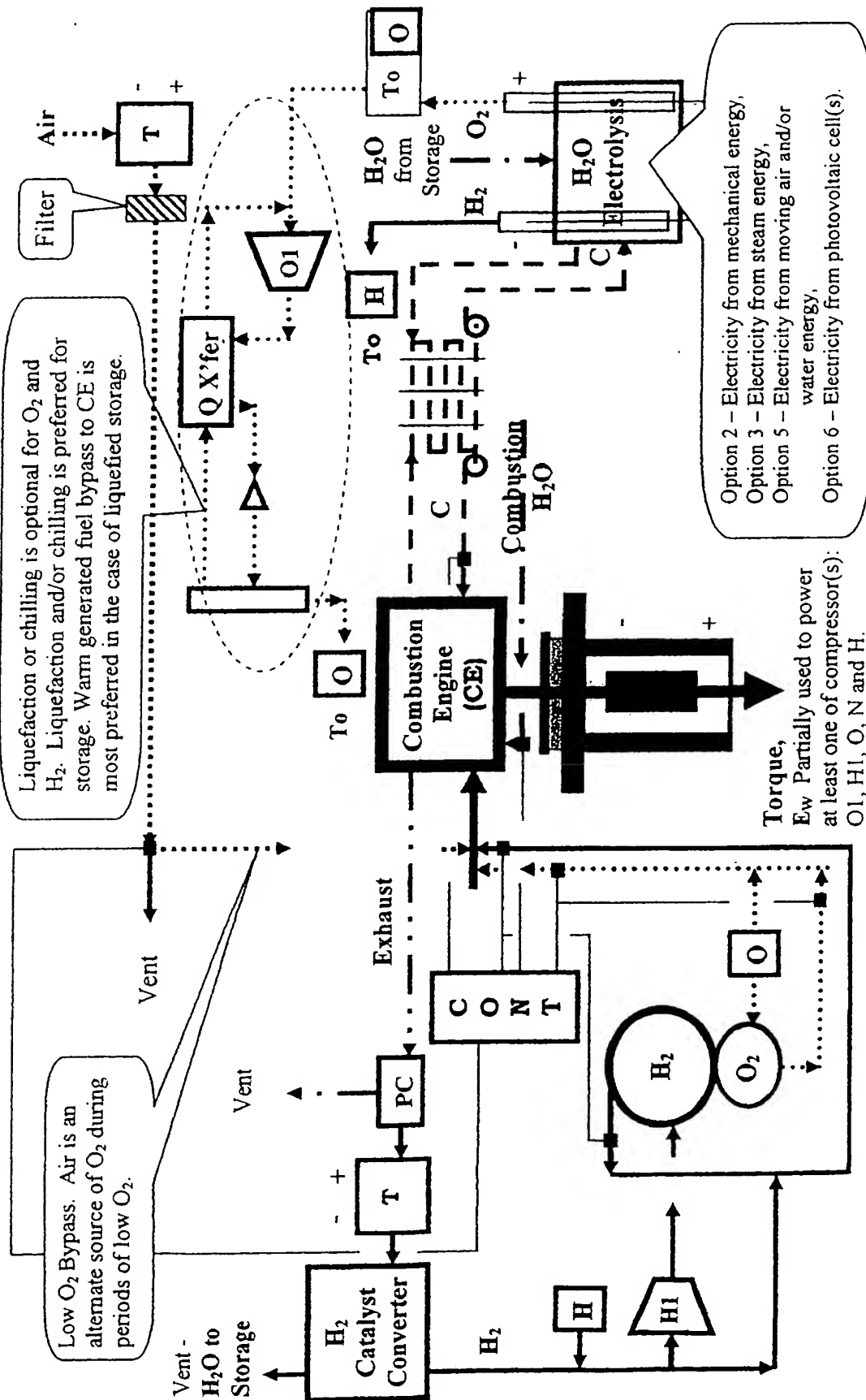
# Replacement Sheet

**Figure 5**  
Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate -  $O_2$  Distillation



# Replacement Sheet

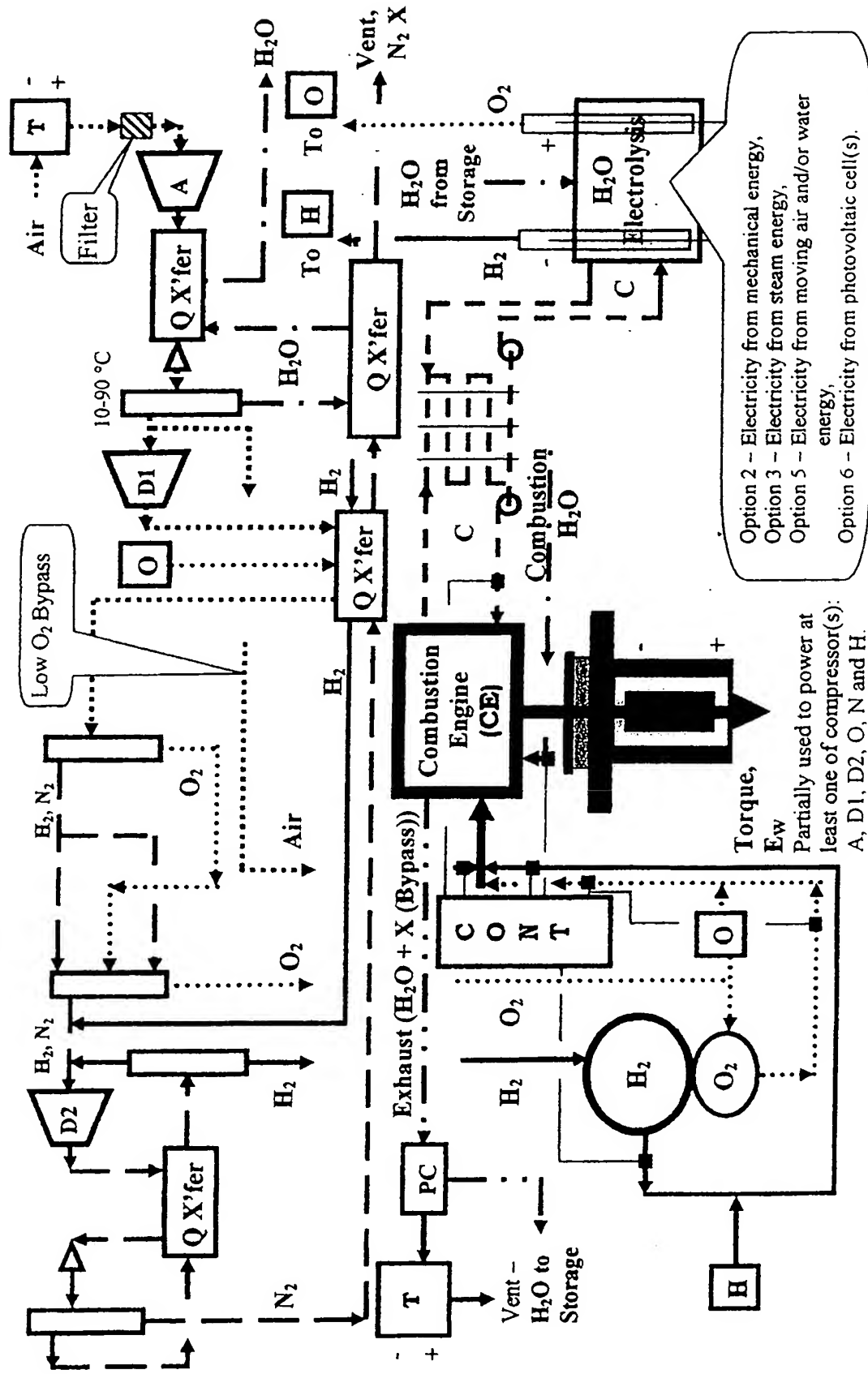
**Figure 6**  
**Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate - Electrolysis -  $H_2$  Catalysis**



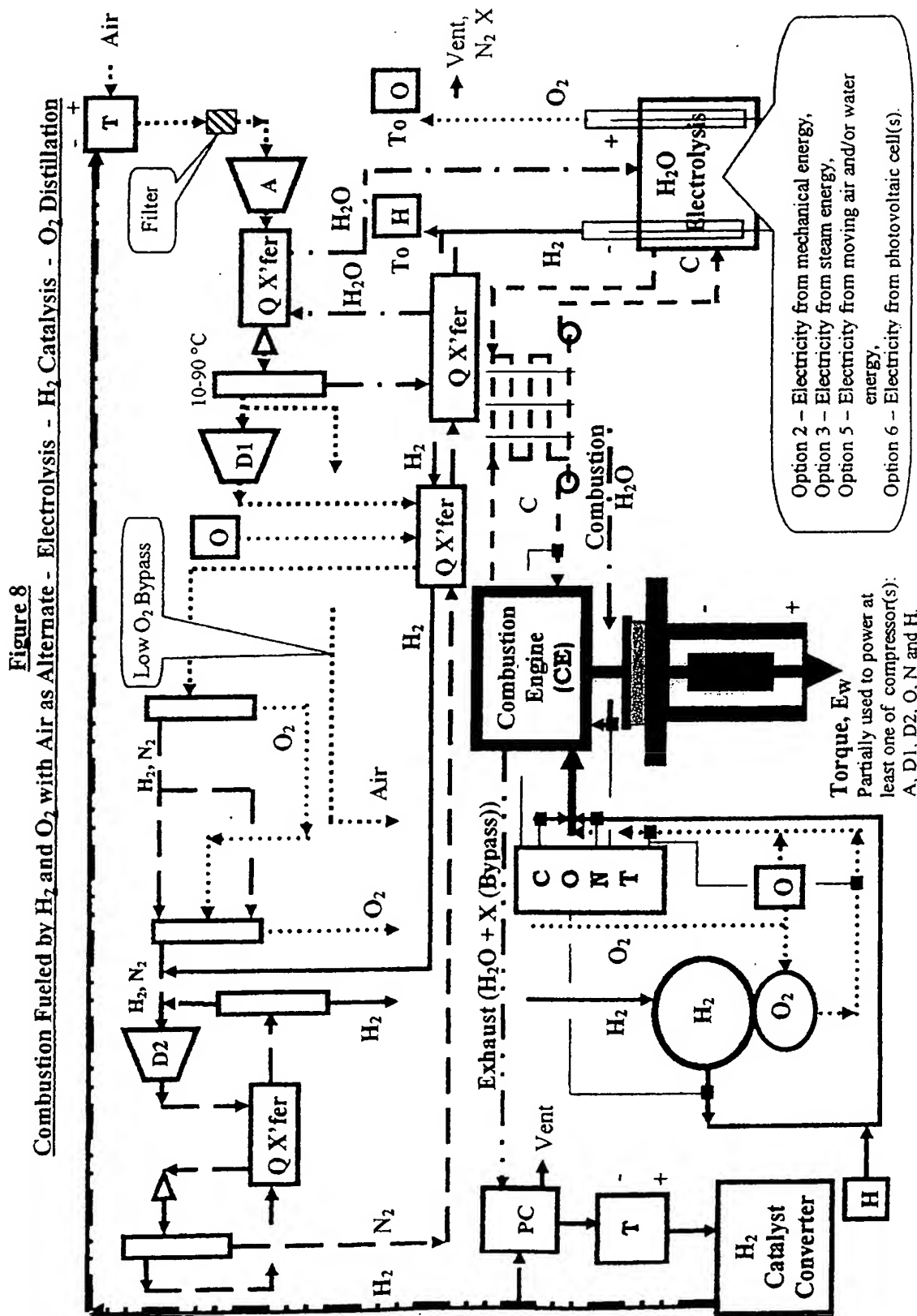


# Replacement Sheet

Figure 7  
Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate - Electrolysis -  $O_2$  Distillation

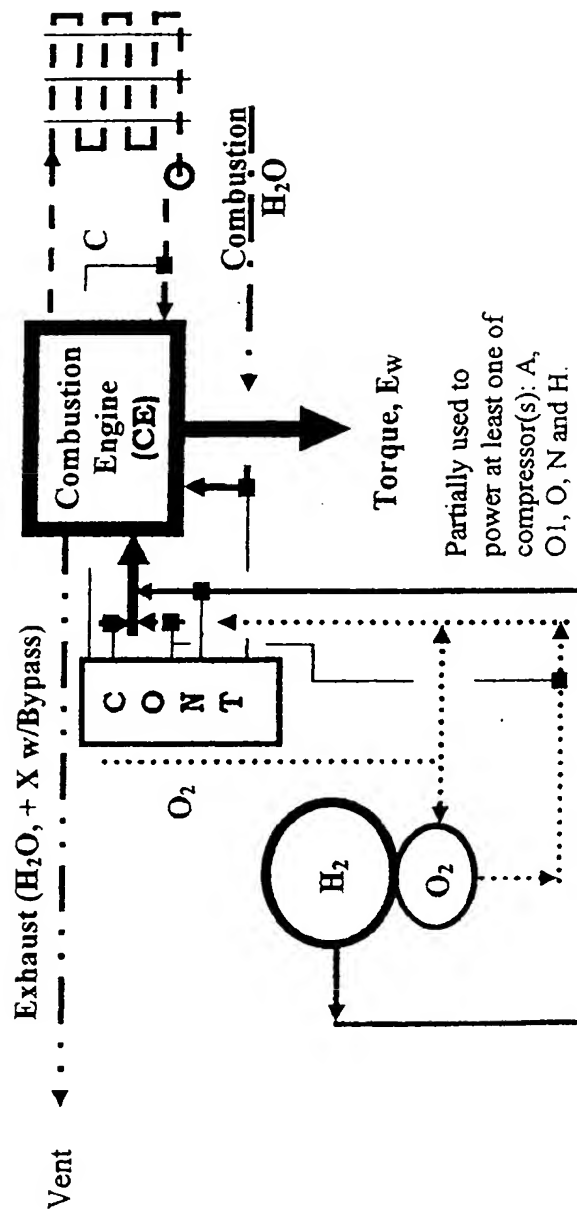
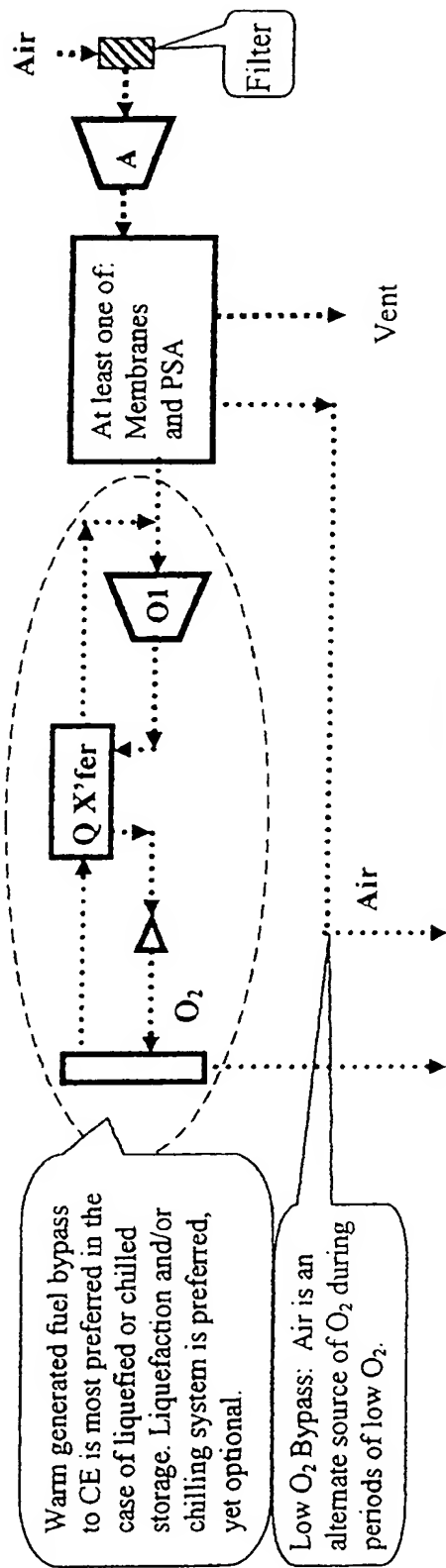


# Replacement Sheet



# Replacement Sheet

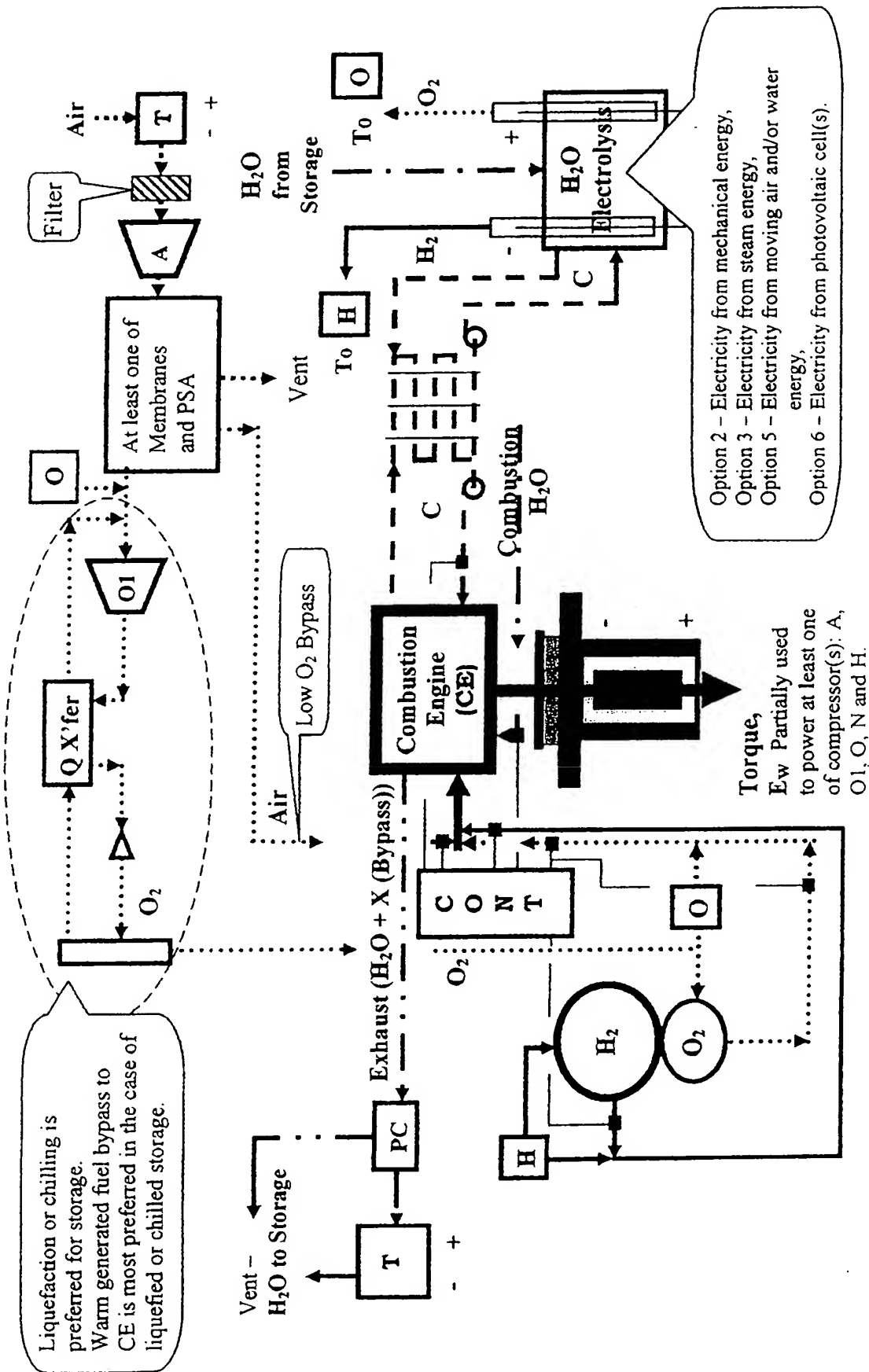
Figure 9  
Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate -  $O_2$  Separation by Membranes or PSA



# Replacement Sheet

Figure 10

Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate - Electrolysis -  $O_2$  Separation by Membranes or PSA



# Replacement Sheet

Figure 11

Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate - Electrolysis -  $H_2$  Catalysis  $O_2$  Separation by Membranes or PSA

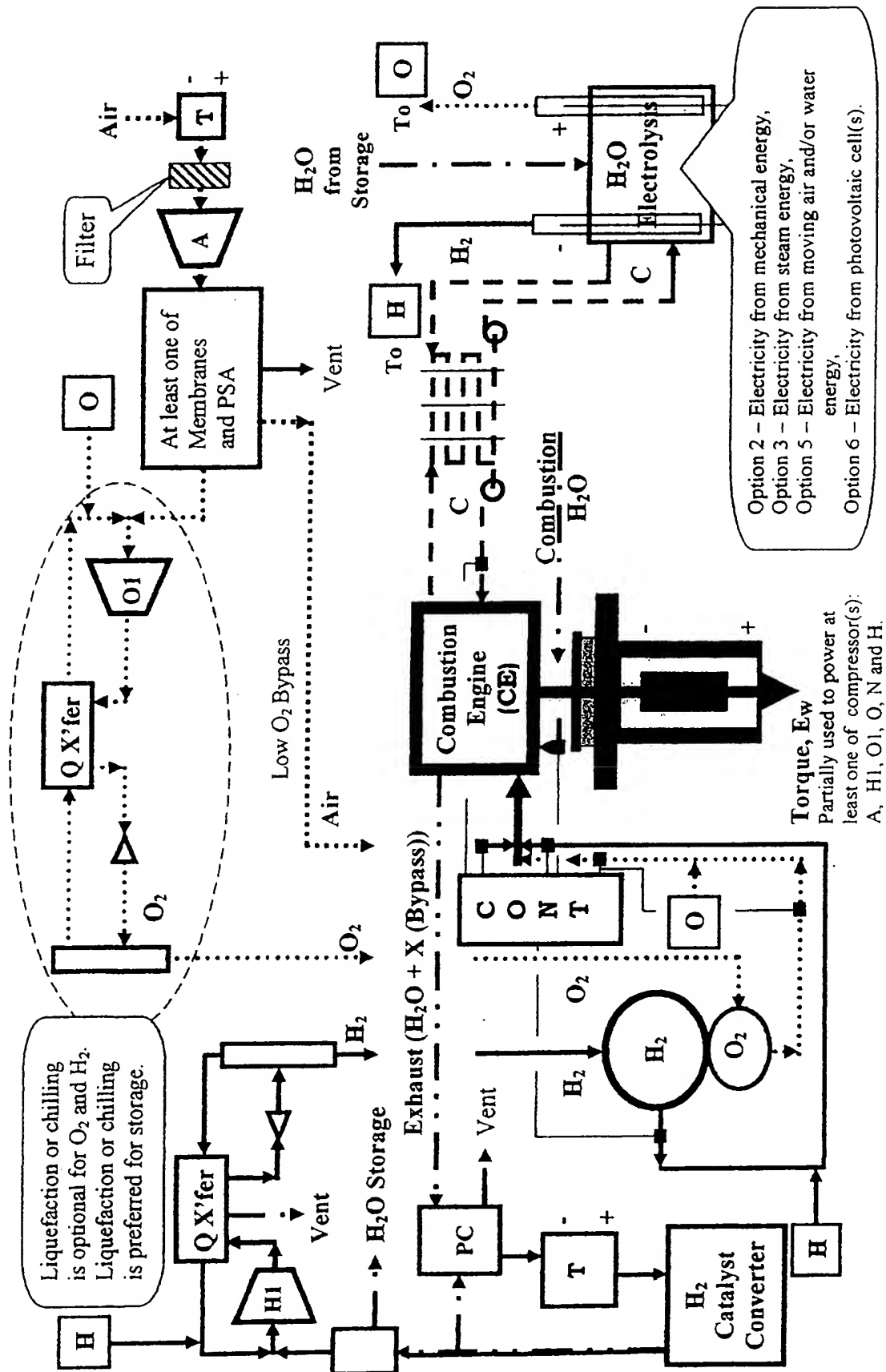
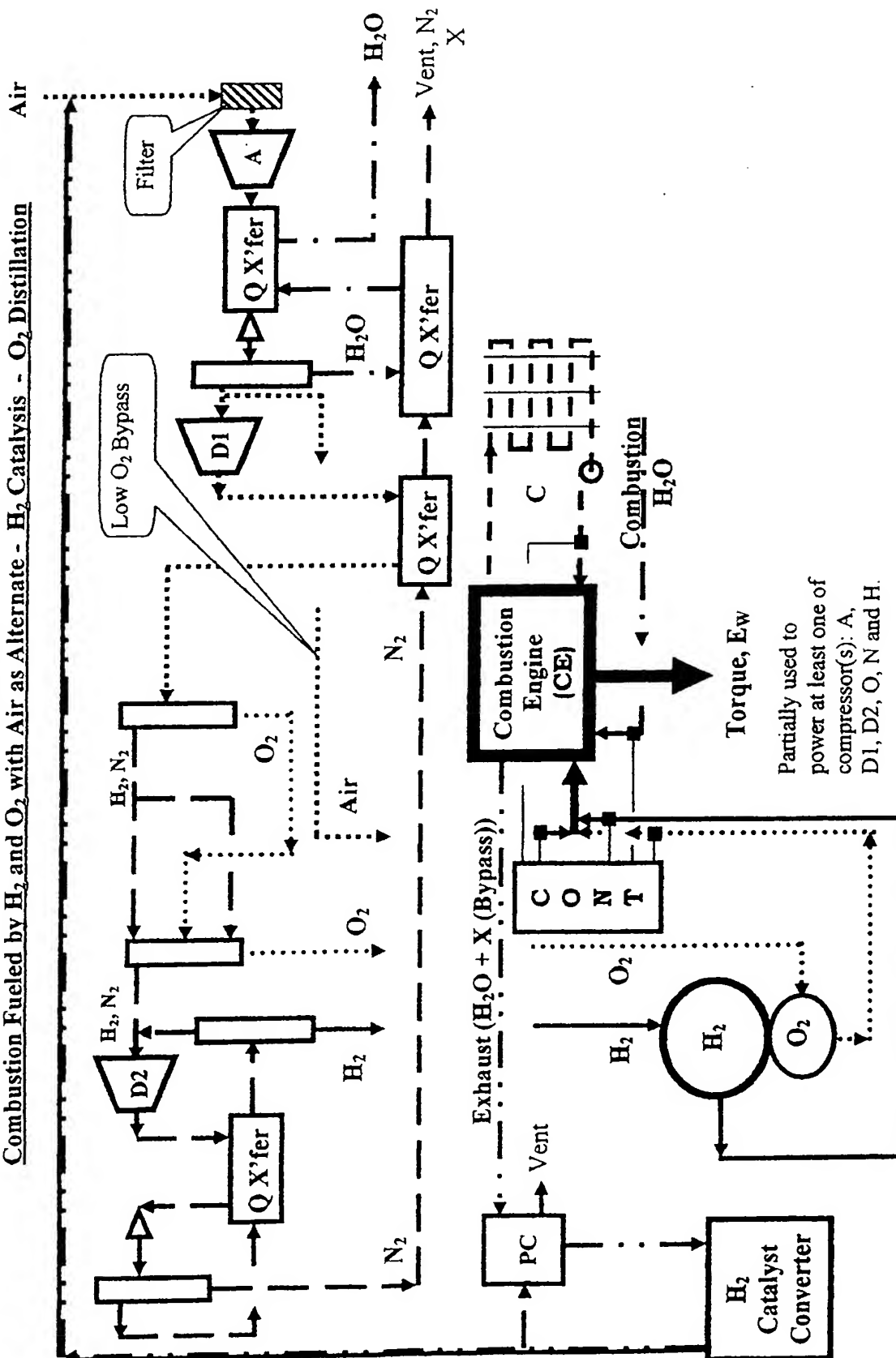
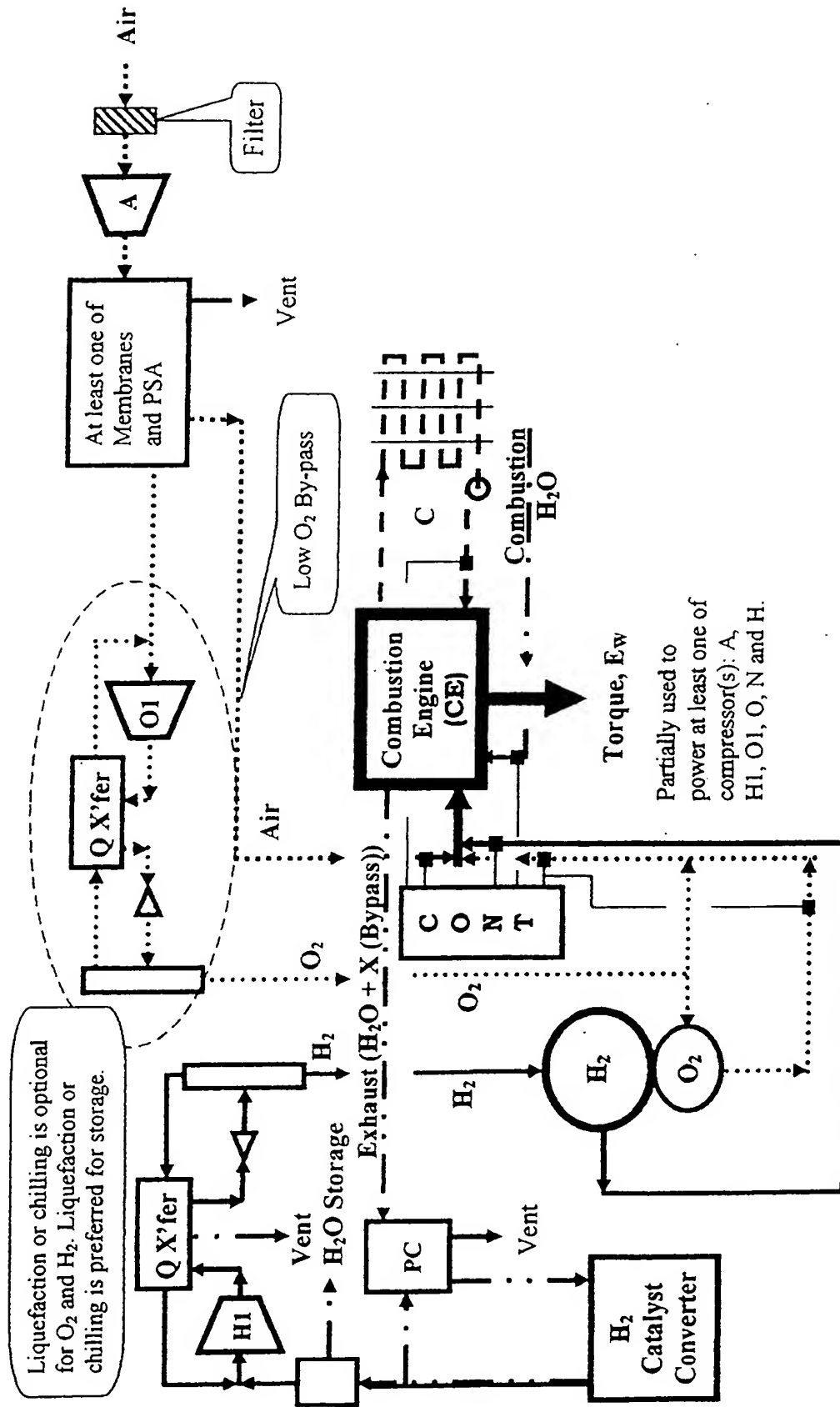


Figure 12

Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate -  $H_2$  Catalysis -  $O_2$  Distillation



**Figure 13**  
**Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate -  $H_2$  Catalysis  $O_2$  Separation by Membranes or PSA**



# Replacement Sheet

Figure 14  
Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate -  $H_2$  Catalysis

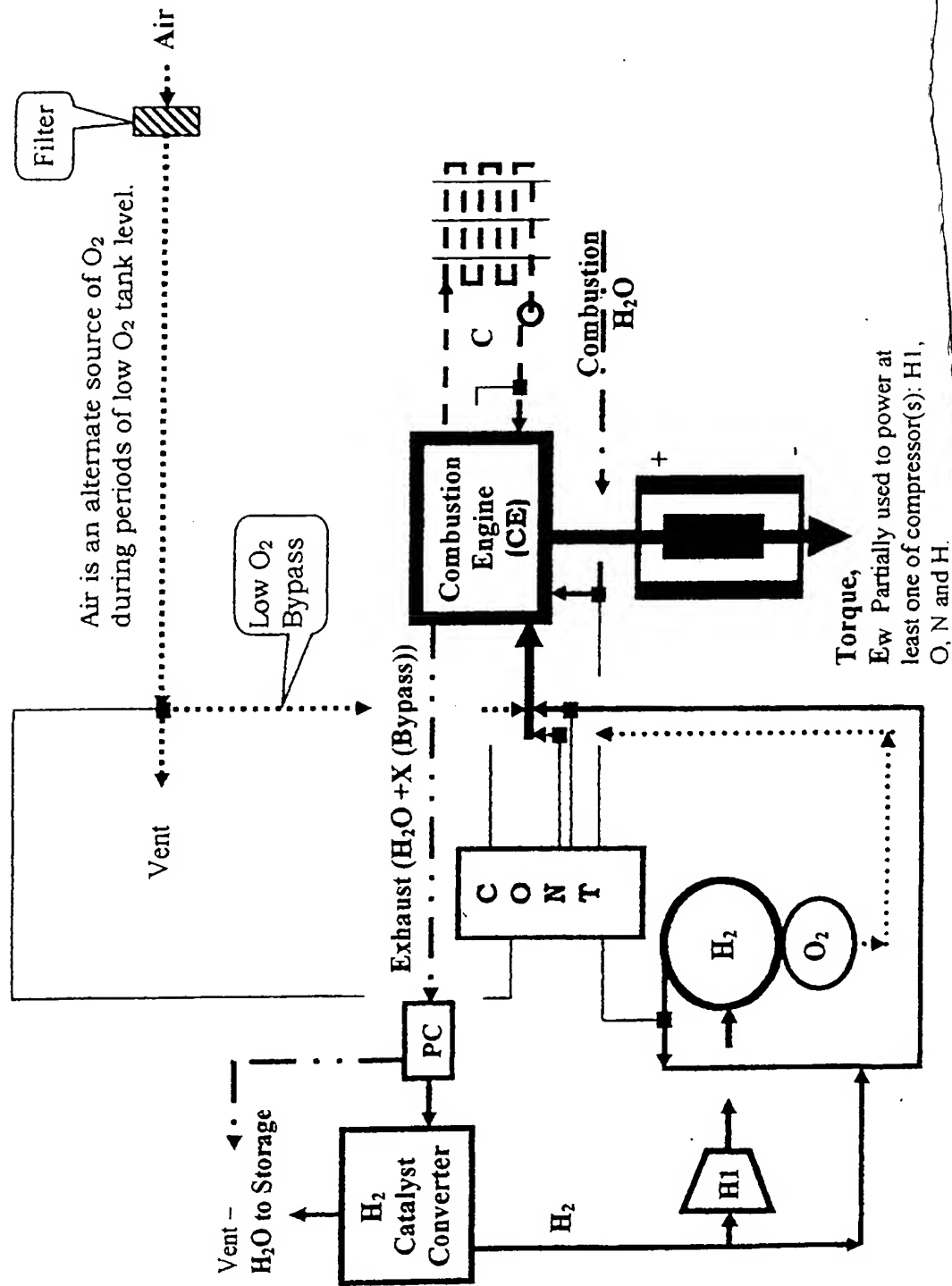
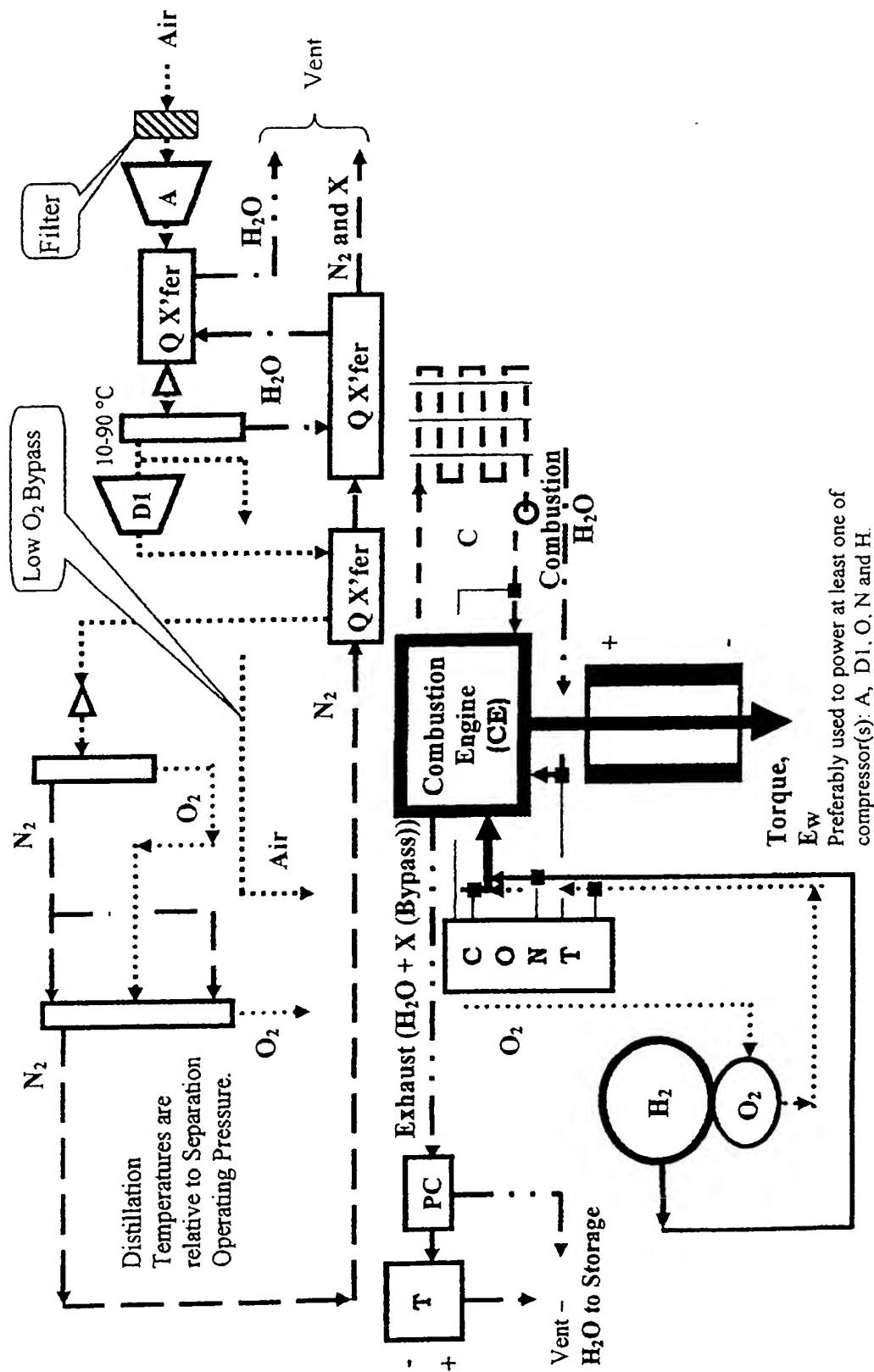


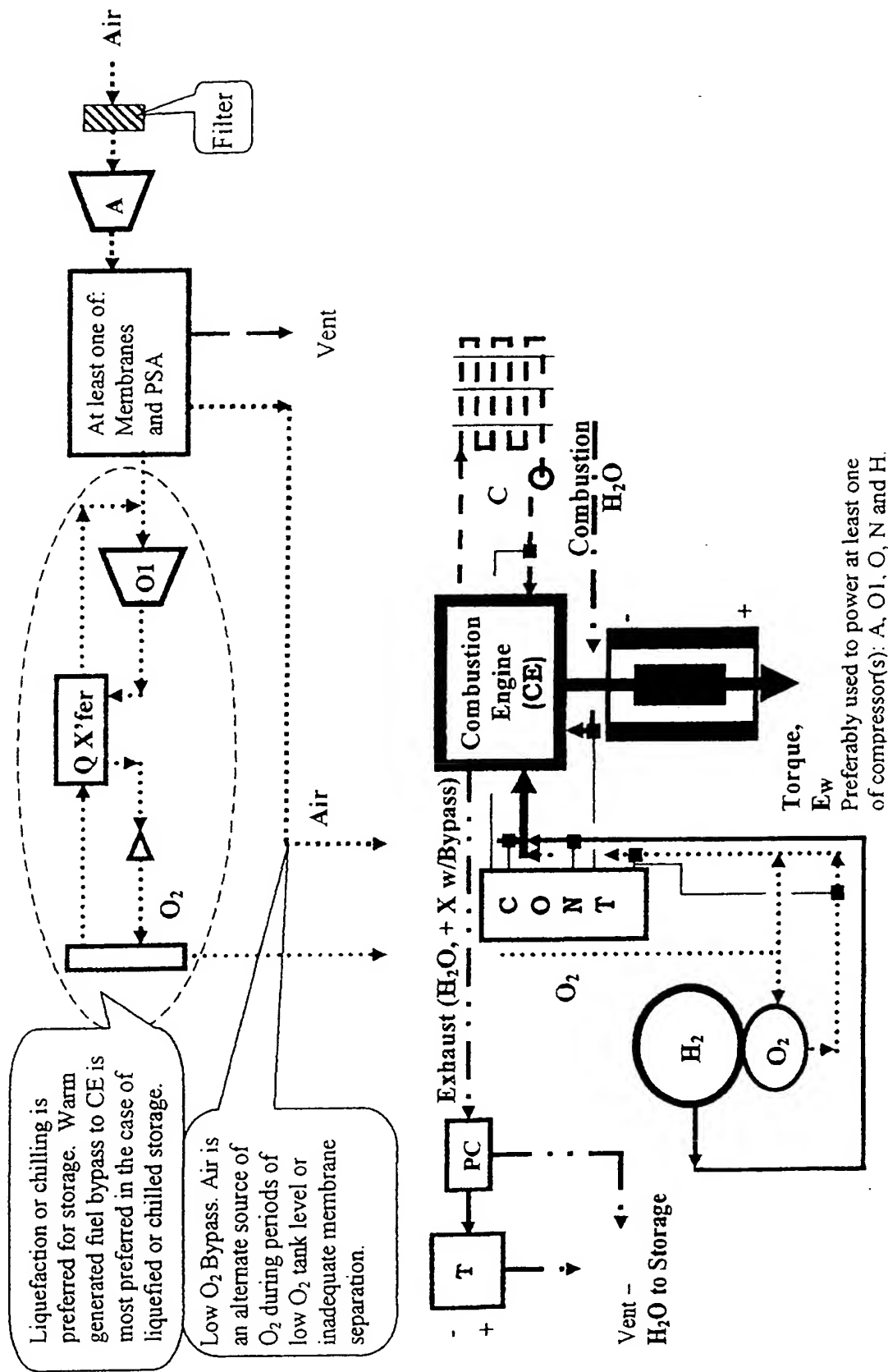


Figure 15  
Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate -  $O_2$  Distillation



Preferably used to power at least one of compressor(s): A, DI, O, N and H.

Figure 16  
Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate -  $O_2$  Separation by Membranes or PSA



## Replacement Sheet

**Figure 17**  
**Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate -  $H_2$  Catalysis -  $O_2$  Distillation**

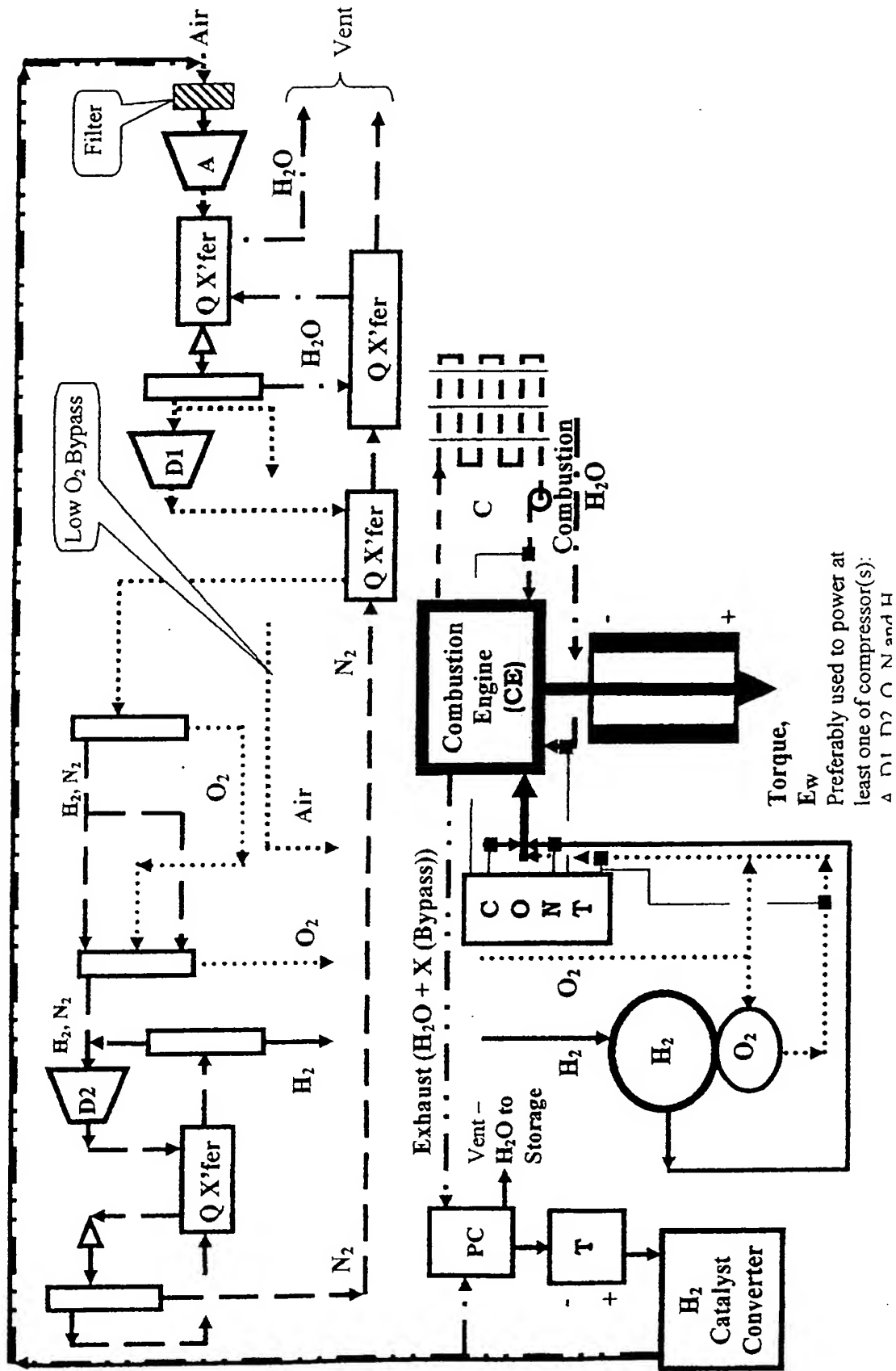
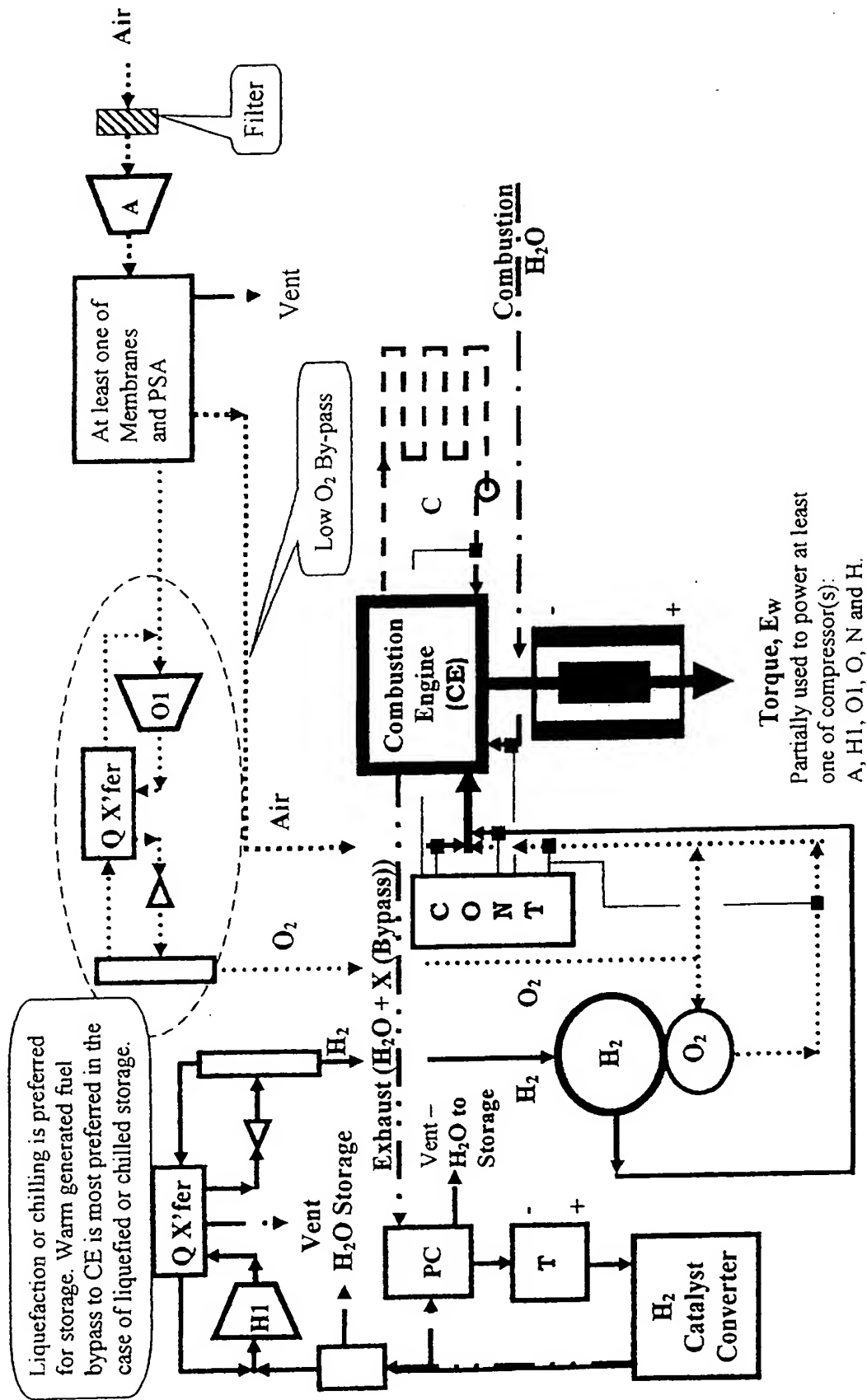


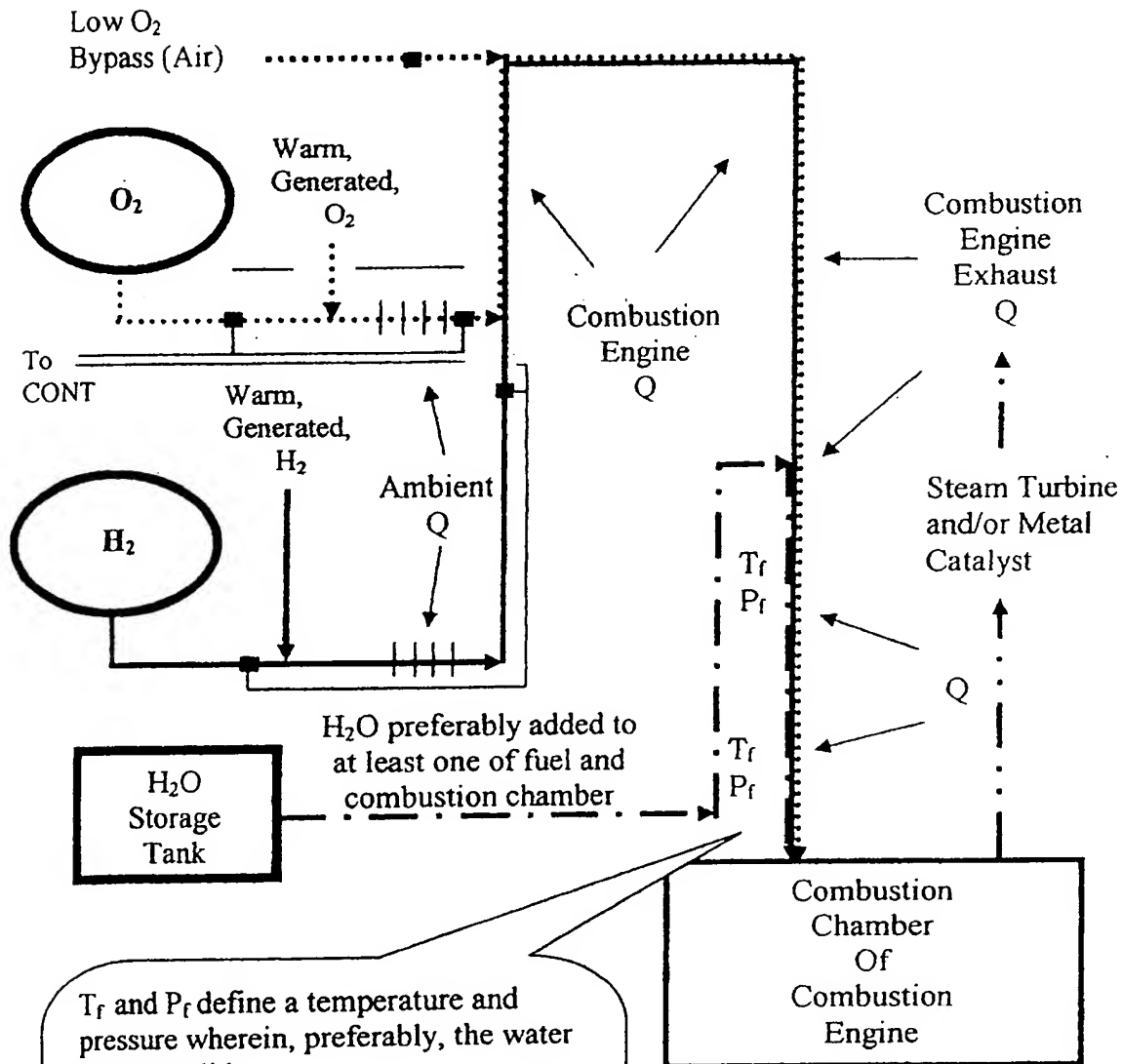
Figure 18

Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate -  $H_2$  Catalysis  $O_2$  Separation by Membranes or PSA



# Replacement Sheet

**Figure 19**  
**Combustion Fueled by  $H_2$  and  $O_2$  and/or Air - Fuel Preheating**

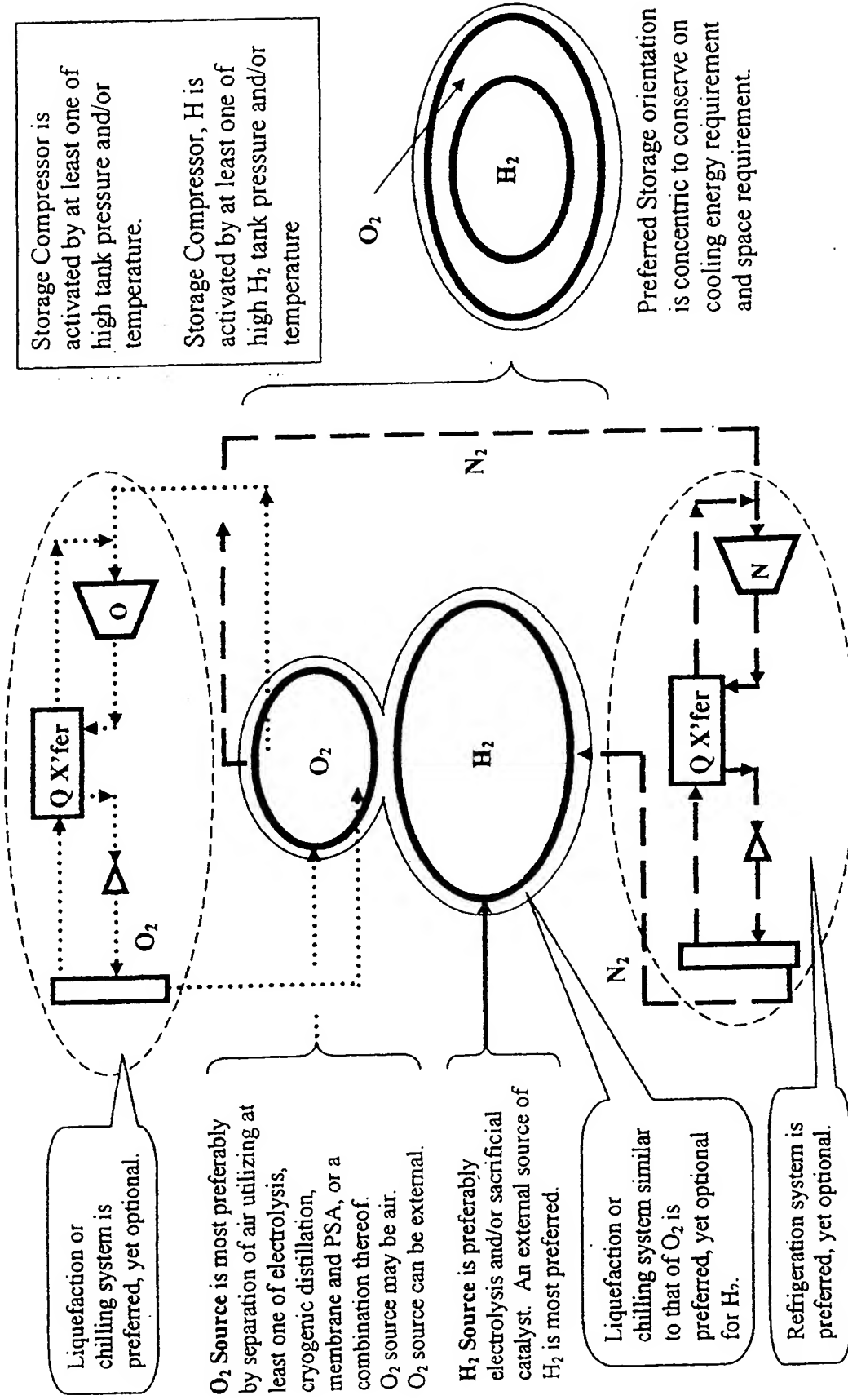


$T_f$  and  $P_f$  define a temperature and pressure wherein, preferably, the water is not a solid.

The fuel mixture of  $O_2$  (or Air during bypass),  $H_2$  and  $H_2O$  defines a mix whereupon at the firing conditions combustion can be maintained without creating a heat issue to the materials of construction for the combustion engine.

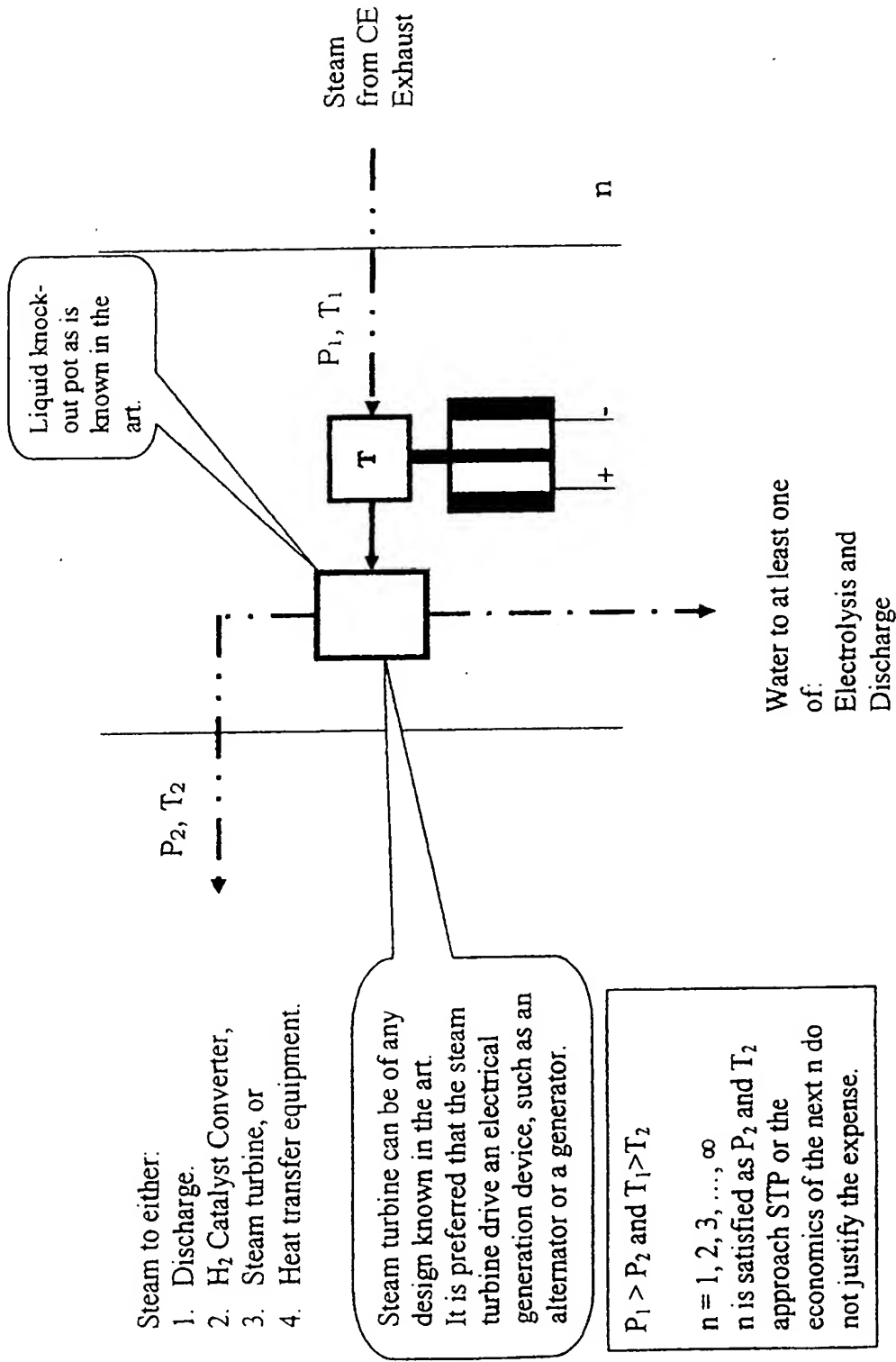
# Replacement Sheet

**Figure 20**  
**Combustion Fueled by  $H_2$  and  $O_2$  and/or Air -  $O_2$  and  $H_2$  Storage**



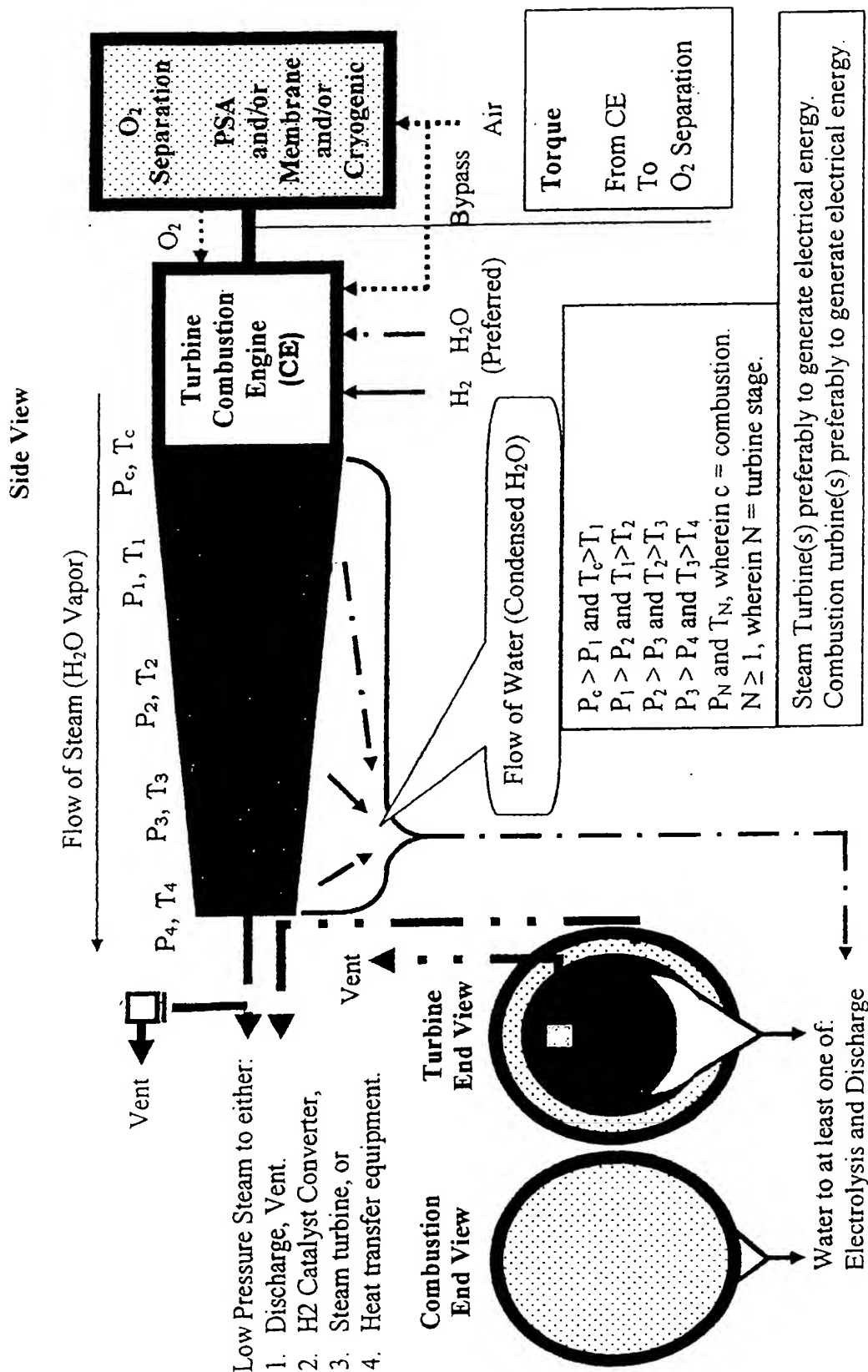
# Replacement Sheet

Figure 21  
Steam Turbine Configuration(s)



# Replacement Sheet

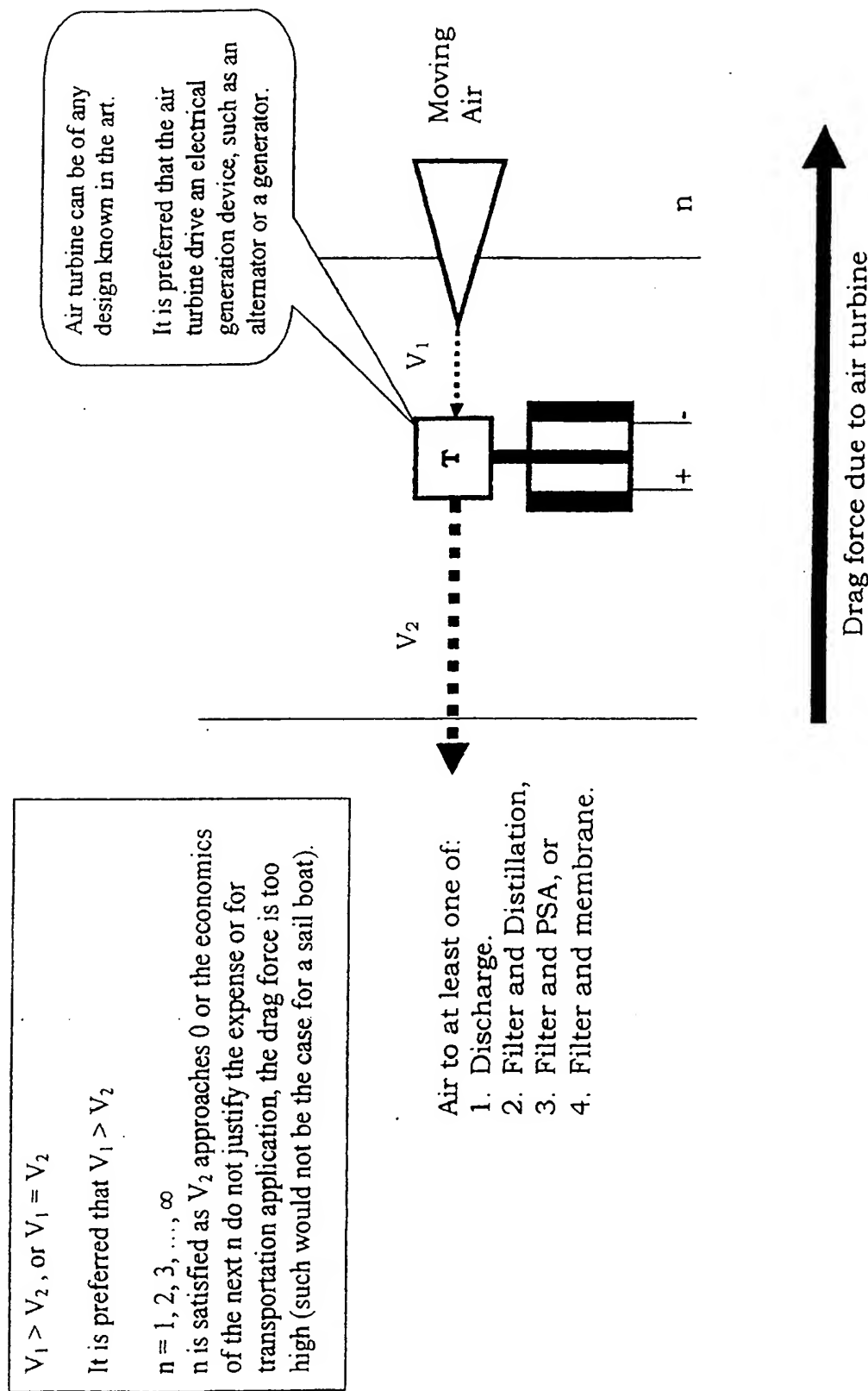
Figure 21A  
In-Line Combustion and Steam Turbine Configuration(s)





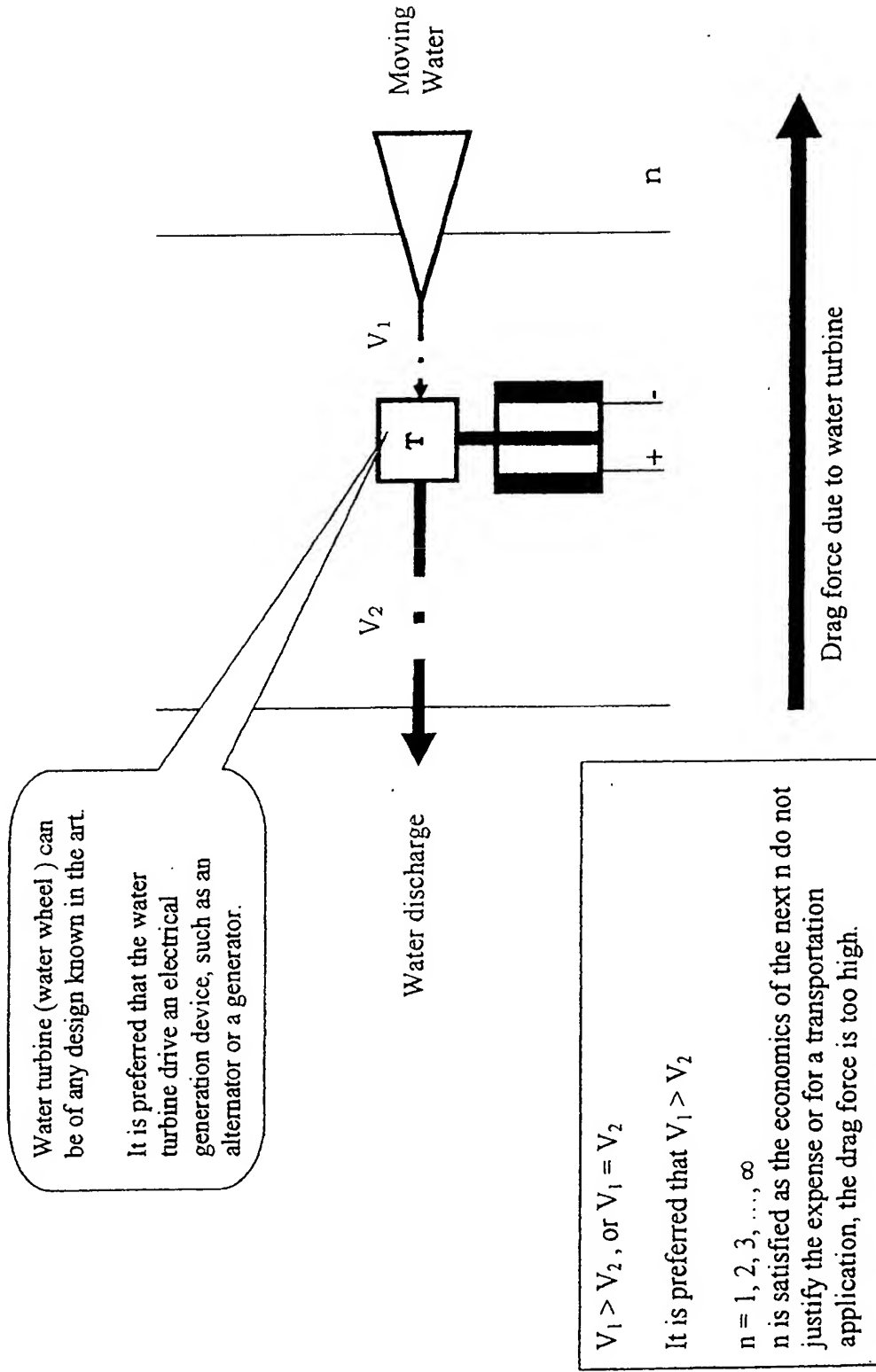
# Replacement Sheet

**Figure 22**  
**Air Movement Turbine Configuration(s)**

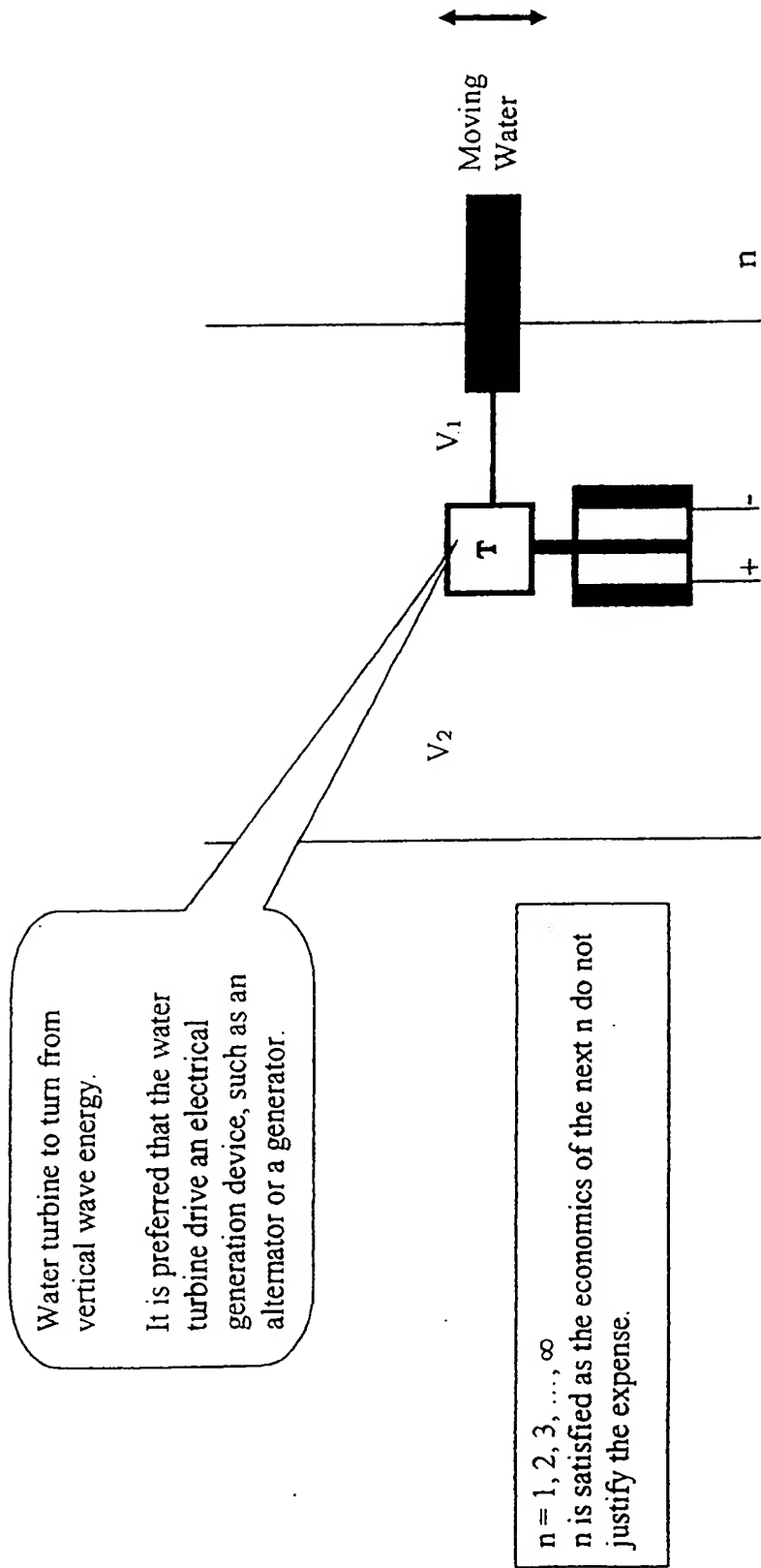


## Replacement Sheet

**Figure 23**  
**Horizontal Water Movement Turbine Configuration(s)**

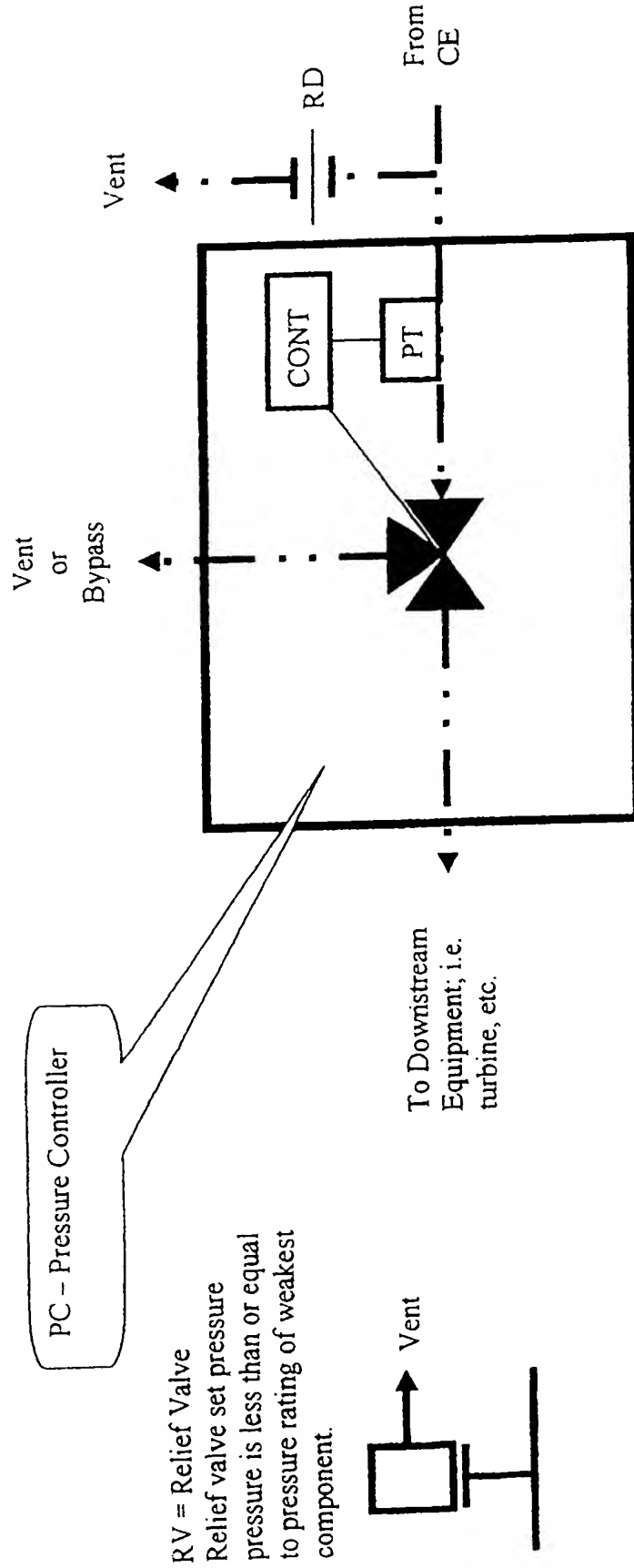


**Figure 23A**  
**Vertical Water Movement Turbine Configuration(s)**

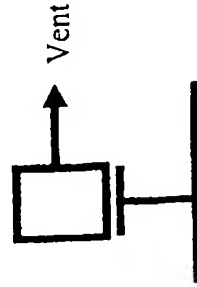


# Replacement Sheet

**Figure 24**  
**Pressure Control Configuration(s)**



RV = Relief Valve  
Relief valve set pressure  
pressure is less than or equal  
to pressure rating of weakest  
component.

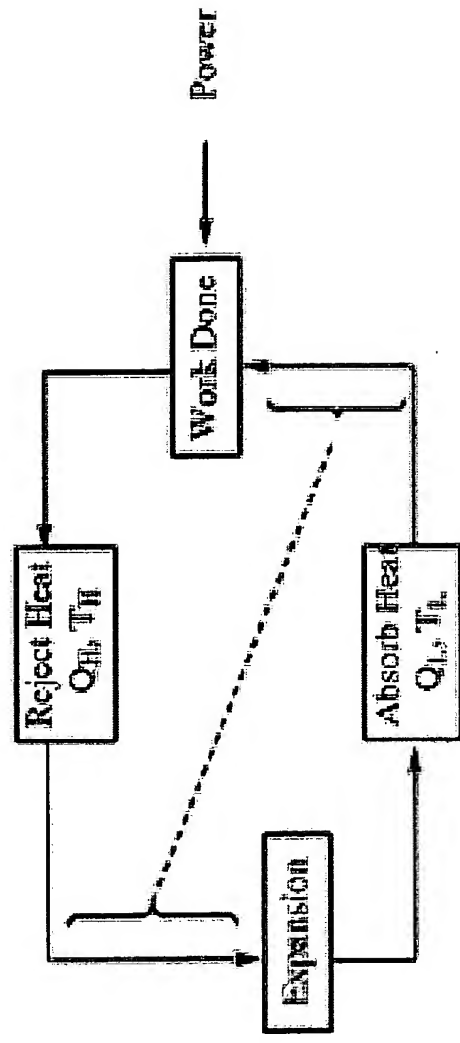


Vent  
RD = Rupture Disc  
Relief Pressure is less than  
or equal to pressure rating of  
weakest component.

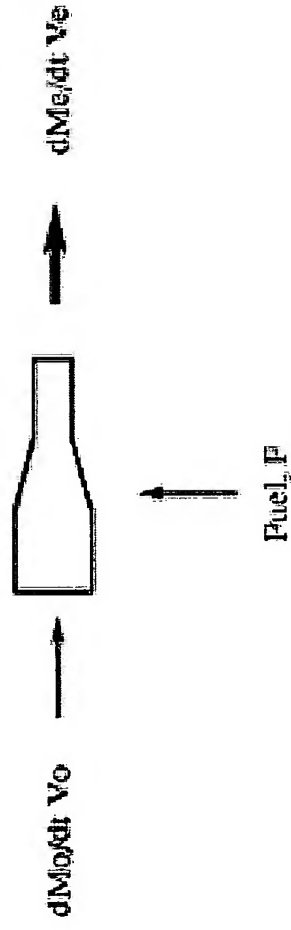
Rupture disc and/or relief valve(s) located downstream of each  
compressor and the combustion engine.  
Vent is the tail pipe or exhaust pipe for the engine.  
In case of a fire, RD or RV preferred on fuel storage tanks.  
Due to MW, density and flammability of fuel, vent(s) is  
preferred near top or behind CE.

Figure 25

Methods and Processes of Refrigeration and Liquefaction



**Figure 26**  
**Methods and Processes of a Jet Engine**



Thrust=Force= $F=dM_e/dt \cdot V_e-dM_o/dt \cdot V_o$ ; Let  $M_e=M_o+M_F$ , wherein  $M_F$ =mass of fuel.